PLANT SELECTION FOR NESTING BY *OECOPHYLLA SMARAGDINA*, HYMENOPTERA: FORMICIDAE: DO PHYSICAL FEATURES AFFECT THE CHOICE OF THE PLANT?[1]

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The weaver ant, *Oecophylla smaragdina* Fabricius is the only species of ant in the Old World to build nests on plants by tying leaves together with silk secreted by the larvae. Although the ant is widespread in its distribution in southern India, it was not found to nest uniformly across its range of distribution. One possible reason for such a variation could be the lack of suitable plants for nesting. Investigations, therefore, were made on the suitability of plants, on the basis of selected physical parameters, to check their influence on the choice of plants for nesting by *O. smaragdina.*

A total of 498 plants belonging to 51 species were examined for the occurrence of nests of *O. smaragdina* in and around the GKVK campus of the University of Agricultural Sciences, Bangalore. A total of 124 nests were located on 19.61% of the species of plants examined, indicating that the ants do not nest on all species of plants. Fourteen physical characters (of leaf or twig) measured either as qualitative or quantitative data, were not found to influence the nesting pattern of the weaver ant. Therefore, the observed variation in nesting pattern may be attributed to other non-physical factors of the plants. The chemistry of the plants or the micro-habitat, i.e. the location of the plant, may influence the nesting pattern of *O. smaragdina.*

Introduction

The weaver ant, *Oecophylla smaragdina* F. is the only member of the tribe Oecophyllini (Formicidae: Formicinae) found in the Old World and is widely distributed in perennial cropping systems throughout southern India. It is considered a nuisance and a pest of many cultivated crops, as it harbours noxious homopterans such as coffee green scales (Hill 1983) for honeydew. On the other hand, its use as a biocontrol agent in several cropping systems is widely appreciated (Way and Khoo 1992). Elsewhere, it is considered a dominant ant, which can influence the structure of the ant mosaic (Majer 1993) and the diversity of many other arthropods, because it is a carnivore. Though similar evaluations are lacking in India, it is undoubtedly a dominant species in many cultivated and natural perennial systems, particularly along the Western Ghats.

The ant builds the nest by tying leaves with silken threads produced by the ant's own larvae. Some worker ants form a chain to connect the leaves of the plant and then pull them together, so that the margins of the leaves overlap. Other workers bring the advanced stage larvae close to the overlapping edges and move them criss-cross across the edge to seal it. Nest construction using leaves appears to be a continuous process, as nests of all sizes can be found on different parts of the plant (Holldobler and Wilson 1990). The nest is expanded by joining more leaves to increase its volume, which also results in the formation of different enclosures within the nest. Although the ant is known to build nests on a wide variety of plants, the plant factors that influence the ant's colonisation pattern have been little studied. It is believed that the ant prefers evergreen, broad-leaved plants to construct nests (Bingham 1903).

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However, the congeneric *O. longinoda* is known to prefer many cultivated plants for nesting. The order of preference shows a strong preference for mango over other cultivated species tested by Djieto-Lordon and Dejean (1999), who did not investigate the characteristics of plant or leaves in relation to the nesting preference of the species. The choice of a plant for nesting is likely to be influenced by both the physical and chemical features of the plant. In this study, we tested some physical features of the plant for their possible role in influencing the nest plant selection by of *O. smaragdina*.

Material and Methods

A total of 498 plants belonging to 51 species in 24 families were examined for nests of *Oecophylla smaragdina* in and around GKVK campus, University of Agricultural Sciences, Bangalore (Table 1). Fourteen physical characteristics of the plants were recorded, in qualitative or quantitative measures. The occurrence of *O. smaragdina* on 51 species of plants measured qualitatively (presence/absence) was checked for association with eight of the fourteen qualitative measures of plants. These included type of plant (shrub/tree), presence/absence of thorns, arrangement of leaves, shape of leaf, texture of leaf, simplicity of leaf, petiolate/sessile leaves and smoothness of leaf margin. The characters measured quantitatively were number of leaflets, internodal length, number of twigs per metre, size of leaf (length, breadth, area). The quantitative measures, grouped into 5-7 classes and the corresponding number of plant species with *O. smaragdina* nests were tabulated. The occurrence of Homoptera colonies on the plants was also recorded.

The qualitative characters were tested for association using 2 x 2 contingency Chi-square. Quantitative characters were divided into 5, 6, or 7 classes, considering the range. Proportional occurrence of plants with and without the nests in each size class was noted. Using the cumulative values of proportional occurrence of plant species in the two categories χ^2 of K-S test (Kolmogorov-Smirnov test, Siegel 1956) for two large samples was then computed to ascertain whether the two distributions differed. Lack of difference would suggest that plants with nests are distributed in all size classes of the character considered and match the natural distribution of the characters in the community. For all these tests, any species with at least one nest, irrespective of the number of plants surveyed, was taken as a plant with nests.

Results

Occurrence of *O. smaragdina* on plants: In all, 124 nests of *O. smaragdina* were located on 34 plants belonging to 10 species spread over 6 families (Table 2). This amounted to 6.83% of plants, 19.61% of species and 25% of families of plants surveyed, indicating that these ants do not nest uniformly on all plant species. Mango, pongamia, tabebuia, cocoa, syzigium, coffee and four unidentified plants were found to harbour ant nests and the percentage plants with nests followed the same order.

Physical features of the Plant: Among the plants observed, 24 species were shrubs and 6 of them harboured nests. Similarly, 27 species were trees and 4 harboured weaver ants. All the ten species of plants with nests were found to be thornless. Five of the plants with nests had opposite leaves while the remaining had alternate leaves. The ants were observed to nest on plants with both simple and compound, petiolate leaves, but only two were in the latter category. Six of the plants with nests had elongate leaves, while four had oval leaves. All these ten plants had smooth leaf margin and only one had leaves with a rough surface. The details of qualitative characters and plants exhibiting them are included in Table 3. All the ten plants with nests were found within the range of five leaflets per

Table 1: Plant species screened for the occurrence of *Oecophylla smaragdina* in and around GKVK, Bangalore

Sl. No.	Name	Common name	Family	No. of plants examined	No. of trees with nests	Total No. of nests	% plants with nests	Mean No. of nests\tree
1	*Tabebuia argentea*	Tabebuia	Bignoniaceae	23	7	9	30.43	0.39
2	*Cocos nucifera*	Coconut	Palmaceae	66	0	0	0	0
3	*Leucaena leucocephala*	Subabul	Fabaceae	123	0	0	0	0
4	*Pongamia glabra*	Pongamia	Fabaceae	24	8	50	33.43	2.08
5	*Psidium guajava*	Guava	Myrtaceae	2	0	0	0	0
6	*Coffea robusta*	Coffee	Rubiaceae	16	1	3	6.25	0.18
7	*Theobroma cacao*	Cocoa	Sterculiaceae	5	1	2	20.00	0.40
8	*Elaterium cardamomum*	Cardamom	Zingiberaceae	12	0	0	0	0
9	*Erythrina indica*	Erythrina	Fabaceae	14	0	0	0	0
10	*Mangifera indica*	Mango	Anacardiaceae	16	8	30	50.00	1.87
11	*Gliricidia maculata*	Gliricidia	Fabaceae	9	0	0	0	0
12	*Grevillea robusta*	Silver oak	Proteaceae	4	0	0	0	0
13	*Ficus bengalensis*	Ficus	Moraceae	3	0	0	0	0
14	*Syzygium cumini*	Jamun	Myrtaceae	17	3	12	17.64	0.70
15	*Santalum album*	Sandal	Santalaceae	3	0	0	0	0
16	*Anacardium occidentale*	Cashew	Anacardiaceae	7	0	0	0	0
17	*Eucalyptus hybrida*	Eucalyptus	Myrtaceae	5	0	0	0	0
18	*Brassaia actinophylla*	Umbrella tree	Araliaceae	2	0	0	0	0
19	*Agave* sp.	Agave	Agavaceae	1	0	0	0	0
20	*Bambusa arundinacea*	Bamboo	Graminae	12	0	0	0	0
21	*Roystonea regia*	Bottle palm	Arecaceae	19	0	0	0	0
22	*Araucaria columnaria*	Christmas tree	Pinaceae	2	0	0	0	0
23	*Thuja occidentalis*	Thuja	Cupressaceae	5	0	0	0	0
24	*Pinus* sp.	Pine	Pinaceae	2	0	0	0	0
25	*Tamarindus indica*	Tamarind	Fabaceae	2	0	0	0	0
26	*Albizia* sp.	Albizia	Mimosaceae	4	0	0	0	0
27	*Anona squamosa*	Custard apple	Annonaceae	1	0	0	0	0
28	*Bauhinia purpurea*	Bauhinia	Caesalpiniaceae	2	0	0	0	0
29	*Azadirachta indica*	Neem	Meliaceae	8	0	0	0	0
30	*Averrhoa carambola*	Carambola	Averrhoaceae	1	0	0	0	0
31	*Ailanthus excelsa*	Match wood tree	Simaroubaceae	2	0	0	0	0
32	*Plumeria alba*	Temple tree	Apocynaceae	1	0	0	0	0
33	*Tectona grandis*	Teak	Verbenaceae	3	0	0	0	0
34	Unidentified sp1			1	0	0	0	0
35	Unidentified sp2			7	1	3	14.28	0.42
36	Unidentified sp3			1	0	0	0	0
37	Unidentified sp4			1	0	0	0	0
38	Unidentified sp5			7	1	1	14.28	0.14
39	Unidentified sp6			18	3	8	16.66	0.44
40	Unidentified sp7			4	0	0	0	0
41	Unidentified sp8			1	0	0	0	0
42	Unidentified sp9			1	0	0	0	0
43	Unidentified sp10			7	0	0	0	0
44	Unidentified sp11			2	0	0	0	0
45	Unidentified sp12			2	0	0	0	0
46	Unidentified sp13			1	0	0	0	0
47	Unidentified sp14			1	1	6	100.0	1.00
48	Unidentified sp15			11	0	0	0	0
49	Unidentified sp16			1	0	0	0	0
50	Unidentified sp17			2	0	0	0	0
51	Unidentified sp18			12	0	0	0	0

Table 2: Occurrence of *Oecophylla smaragdina* nests on plants

	Oecophylla Nests				
	Present	Percent	Absent	Percent	Total
No. of plants	34	6.83	464	93.17	498
No. of species	10	19.61	41	80.39	51.00
No. of families	6	25.00	18	75.00	24

Table 3: Association between qualitative characters of plants and nesting by *Oecophylla smaragdina* at GKVK Campus

Plant character	Plant with nest	Plant without nest	Chi-square	Significance P<0.05
Type of plant				
Shrub	6	18	0.314	NS
Tree	4	23		
Thorns				
Present	0	4	0.139	NS
Absent	10	37		
Arrangement of leaves				
Opposite	5	18	0.00005	NS
Alternate	5	23		
Type of leaves				
Simple	8	24	0.799	NS
Compound	2	17		
Petiolated condition				
Petiolate	10	31	0.574	NS
Sessile	0	10		
Shape of leaves				
Elongate	6	25	0.092	NS
Oval	4	16		
Texture of leaves				
Smooth	9	25	0.968	NS
Rough	1	13		
Leaf margin				
Smooth	10	34	0.044	NS
Rough	0	7		

leaf and 37 species of plants without nests had the leaflet numbers in this range. The internodal lengths varied from <1 to 19 cm among the studied plants. These were divided into 6 different classes and all of them were represented among the plants with ants. Number of twigs per metre of the stem ranged up to 60 and was divided into five classes, which were all represented by the plants with nests. Leaf or leaflet length varied from 0.5 to 46.83 cm and the plants could be divided into 7 different classes and all of the categories were represented by plants with ant nests. Similarly, leaf breadth and the leaf area showed considerable variation among the plants checked for ant nests. The plants could be divided into five and six classes with respect to breadth and area respectively. Ants were found on plants of all categories. A summary of these quantitative characters is provided in Table 4.

Nest occurrence and plant characters: The distribution of the fourteen characters among the plants with nests matched the natural distributions of these characters among the 51 species of plants surveyed (Chi-square: 0.5×10^{-4} to 2.62; $p>0.05$ for all the characters). Clearly, the tests indicated that the physical features of the plants considered were not influencing the choice of nesting by the weaver ants (Table 3 & 4).

Table 4: Association between quantitative characters of plants and preference for nesting by *Oecophylla smaragdina* at GKVK Campus

Character	Range	Mean	Chi-Square	Probability <0.05
No. of leaflets/ leaf	3-208	105.50	2.62	NS
Internodal length	0.2-19 cm	9.60	1.47	NS
No. of twigs/m	1-60	30.50	0.55	NS
Leaf length	0.5-46.83 cm	23.66	0.48	NS
Leaf breadth	0.3-17.5 cm	8.90	0.48	NS
Leaf area	0.33-342.2 sq. cm	171.30	0.56	NS

Ants and Homoptera on plants: Colonies of homopterans were found on 29 species of plants. All the plants with ant nests were found to harbour Homoptera, including aphids, scales, mealy bugs and tree-hoppers. The ants were observed to tend only scales and mealy bugs. The association test indicated that ant occurrence is strongly dependent upon the availability of homopteran colonies on the plants (Chi-square: 6.01; $p<0.01$).

Discussion

There has been no evaluation of the role of physical characters of plant in the nesting preference of *O. smaragdina*. The present study shows that physical parameters of the plants considered do not influence the choice of nest plant. Earlier observations indicated that weaver ants nest exclusively on broad-leaved evergreen plants (Bingham 1903). However, in the present study, the ants were recorded on deciduous plants such as Pongamia and on other species which have very small leaflets e.g., *Albizia* sp. Although the study considered only two types of plants i.e. shrubs and trees, it is likely that vines may also be colonised. This study showed that the ants have no preference for plants with specific physical characteristics for nesting. Reasons for the absence of nests on most of the plants species screened could not be established in this study. The occurrence of *O. smaragdina* on plant species may be governed by factors other than their physical features. For example, the nesting efficiency may be influenced by the amount of silk the larva needed to produce to bind the leaves together, as smaller leaves require greater quantities of silk and energy, at the cost of the development of the colony. Yet, such characters were not found to influence the nesting pattern. Clearly, the cost of such nest building may be offset by other benefits that the ant may get from plants with small leaves. This is evident from the strong association observed between the ant nests and the Homopteran colonies among the plants screened.

If physical parameters of the plants are not influencing the nest building on plants, then what other factors govern the *O. smaragdina* nest distribution on plant species? There is some indirect evidence to support the possibility of nest construction by *O. longinoda* being influenced by prior experience of the larvae with the plants (Djieto-Lordon and Dejean 1999). The experience of nesting on a plant could be imprinted in the larvae by chemical signals. Therefore, it is likely that the chemical features of the plants play the most important role in selection for nesting by *O. smaragdina*. But not all plants were uniformly inhabited even among the preferred plants, which suggests other factors like the micro-habitat of the plant as one possible reason to affect the nesting. However, the occurrence of ant nests was strongly associated with the occurrence of Homoptera, particularly scale insects. This suggests that the host plants of these scales may be the most important hosts of the weaver ants. But *O. smaragdina* being a predatory ant, such a strong association between the Homoptera and the ants is surprising. It is possible that the honeydew of the Homoptera is essential for the survival and multiplication of the ants. These aspects of the biology of *O. smaragdina* may be of help in managing them, either in biological control or to reduce their impact as pests of economic importance.

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